

5 26. The protein of claim 1, wherein the variant protein has a Group 4 amino acid residue mutated to a Group 5 amino acid residue at position 153.

10 27. The protein of claim 26 having the mutation C153R.

28. The protein of claim 1, wherein the variant protein has a Group 4 amino acid residue mutated to a Group 1 amino acid residue at position 281.

15 29. The protein of claim 28 having the mutation T281A.

30. The protein of claim 1, wherein the variant protein has Group 3 amino acid residue mutated to a Group 2 amino acid residue at position 367.

20 31. The protein of claim 30 having the mutation N367I.

32. The protein of claim 1, wherein the variant protein has a Group 3 amino acid residue mutated to a Group 6 amino acid residue at position 367.

33. The protein of claim 32 having the mutation N367Y.

30 34. The protein of claim 1, wherein the variant protein has a Group 1 amino acid residue mutated to Group 4 amino acid residue at position 389.

35. The protein of claim 34 having the mutation P389S.

35 36. The protein of claim 1, wherein the variant protein has a Group 1 amino acid residue mutated to a Group 2 amino acid residue at position 389.

40 37. The protein of claim 36 having the mutation P389L.

38. The protein of claim 1 selected from the group consisting of SEQ ID NO:42, SEQ ID NO:43, SEQ ID NO:44, SEQ ID NO:45, SEQ ID NO:46, SEQ ID NO:47, SEQ ID NO:48,

5 SEQ ID NO:49, SEQ ID NO:50, SEQ ID NO:51, SEQ ID NO:53,  
 SEQ ID NO:54, SEQ ID NO:56, SEQ ID NO:57, SEQ ID NO:58,  
 SEQ ID NO:59, SEQ ID NO:61, SEQ ID NO:62, SEQ ID NO:63,  
 SEQ ID NO:64, and SEQ ID NO:65.

10 39. A nucleic acid comprising a polynucleotide sequence  
 encoding an amino acid sequence of a variant protein of  
 the love protein having at least one mutation selected  
 from the group consisting of:

- 15 (a) a Group 6 amino acid residue mutated to a  
 Group 2 amino acid residue at position 31;
- (b) a Group 3 amino acid residue mutated to a  
 Group 5 amino acid residue at position 41;
- (c) a Group 4 amino acid residue mutated to a  
 Group 2 amino acid residue at position 52;
- 20 (d) a Group 4 amino acid residue mutated to a  
 Group 3 amino acid residue at position 52;
- (e) a Group 4 amino acid residue mutated to a  
 Group 5 amino acid residue at position 73;
- (f) a Group 1 amino acid residue mutated to a  
 25 Group 4 amino acid residue at position 101;
- (g) a Group 1 amino acid residue mutated to a  
 Group 3 amino acid residue at position 101;
- (h) a valine amino acid residue mutated to another  
 Group 2 amino acid residue at position 111;
- 30 (i) a Group 4 amino acid residue mutated to a  
 Group 2 amino acid residue at position 133;
- (j) an Group 3 amino acid residue mutated to a  
 Group 2 amino acid residue at position 141;
- (k) an Group 3 amino acid residue mutated to a  
 35 Group 5 amino acid residue at position 141;
- (l) a Group 4 amino acid residue mutated to Group  
 6 amino acid residue at position 153;
- (m) a Group 4 amino acid residue mutated to a  
 Group 5 amino acid residue at position 153;
- 40 (n) a Group 4 amino acid residue mutated to a  
 Group 1 amino acid residue at position 281;
- (o) a Group 3 amino acid residue mutated to a  
 Group 2 amino acid residue at position 367;

- 5 (p) a Group 3 amino acid residue mutated to a  
Group 6 amino acid residue at position 367;  
(q) a Group 1 amino acid residue mutated to Group  
4 amino acid residue at position 389; and  
(r) a Group 1 amino acid residue mutated to a Group  
10 2 amino acid residue at position 389.

40. The nucleic acid of claim 39, wherein the  
polynucleotide encodes a variant protein of the lovE  
protein having a Group 6 amino acid residue mutated to a  
15 Group 2 amino acid residue at position 31.

41. The nucleic acid of claim 40 having the mutation  
F31L.

20 42. The nucleic acid of claim 39, wherein the  
polynucleotide encodes a variant protein of the lovE  
protein having a Group 3 amino acid residue mutated to a  
Group 5 amino acid residue at position 41.

25 43. The nucleic acid of claim 42 having the mutation Q41K  
or Q41R.

44. The nucleic acid of claim 39, wherein the  
polynucleotide encodes a variant protein of the lovE  
30 protein having a Group 4 amino acid residue mutated to a  
Group 2 amino acid residue at position 52.

45. The nucleic acid of claim 44 having the mutation  
T52I.

35 46. The nucleic acid of claim 39, wherein the  
polynucleotide encodes a variant protein of the lovE  
protein having a Group 4 amino acid residue mutated to a  
Group 3 amino acid residue at position 52.

40 47. The nucleic acid of claim 46 having the mutation  
T52N.